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[Title of the Invention] EXPOSURE APPARATUS AND METHOD OF PRODUCING DEVICE

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[Name of Document] SPECIFICATION

[Title of the Invention] EXPOSURE APPARATUS AND METHOD OF PRODUCING DEVICE

[Claim]

[Claim 1] An exposure apparatus comprising a part made of resin inside thereof, and temperature control means for controlling the surface temperature of the resin part at a predetermined temperature or lower.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to an exposure apparatus with which a fine circuit pattern is transferred and, more particularly, to an exposure apparatus having piping made of a high polymer material (i.e., piping made of resin) and arranged inside the exposure apparatus.

[0002]

[Description of the Related Art]

Hitherto, as a printing method (e.g., photolithography) for forming fine semiconductor elements such as semiconductor memories, logic circuits or the like, reduction projection exposure has been employed. The minimum size of an object which can be transferred by the reduction projection exposure is proportional to the wavelength of light used for the transfer, and is inversely

proportional to the numerical aperture of the projection optical system. Therefore, light beams having shorter wavelengths have been applied to transfer finer circuit patterns. In particular, ultra-violet (UV) rays having shorter wavelengths have been employed. That is, mercury lamp i rays (365 nm in wavelength), KrF excimer laser beams (248 nm in wavelength), and ArF excimer laser beams (193 nm in wavelength) have been used. At present, an exposure apparatus using UV rays having a still shorter wavelength, i.e., F2 laser beams (157 nm in wavelength) is under development. In the wavelength range of the F2 laser, the absorption of the beams into oxygen is not negligible. Thus, an exposure apparatus using the F2 laser has a structure in which an inert gas such as nitrogen, helium, or the like can be filled in the spaces through which the light beams travel.

[0003]

For efficient printing of very fine circuit patterns with a size of less than 0.1 μm, a reduction projection exposure apparatus using extreme UV (EUV) rays having a still shorter wavelength than UV rays, i.e., having a wavelength of about 10 to 15 nm, has been developed. Moreover, an exposure apparatus using an electron beam has been developed. Referring to exposure apparatuses using electron beams (EB), different types of exposure apparatuses, e.g., a direct-writing system, a multiple-electron-source

system, a stencil mask system, and the like, have been developed. For the above-described exposure apparatuses using EUV rays and EB, it is necessary to set the light-path space in a high vacuum state or in a reduced pressure environment.

[0004]

However, when light beams having short wavelength are used for exposure, the light energy is increased, so that the light beams decompose slight amounts of carbon compounds which have been gasified and are present in the light paths. In some cases, due to the light energy, substances produced by the decomposition are deposited on and adhere to optical elements such as lenses, mirrors, stops and the like which constitute the exposure apparatus. Thus, in the case of lenses, the transmittance is reduced. In the case of mirrors, the reflectivity becomes low. In the case of stops, the sizes and shapes are changed. Hence, the performances of the optical elements are deteriorated when substances produced by the decomposition adhere to the optical elements. When the respective optical elements are deteriorated, the radiation intensity (i.e., optical strength) or imaging-performance of the exposure apparatus is changed. Thus, the optical performance required of the exposure apparatus is deteriorated. In order to overcome the problem of deteriorated optical performance, a significant amount of

labor and time is required to disassemble and clean the optical system. Therefore, countermeasures against the above described problems have been investigated. For example, it has been considered to fill the optical path space (i.e., exposure space) with a high-purity inert gas that does not decompose with light, or to keep the optical path space in a high vacuum state.

[0005]

Present-day exposure apparatuses are provided with parts made of resins containing carbon compounds which may be deposited on and adhere to optical elements, deteriorating the performance of the exposure apparatuses. It is not practical to form exposure apparatuses which exclude resin parts. For example, when a wafer and a reticle are scanned and exposed, stages for moving the wafer and reticle are driven in the X-, Y-, and Z-axial directions and, moreover, the stages are driven rotationally. If the temperature of the wafer or reticle placed on the stage cannot be kept constant and uniform, deterioration of the transfer accuracy will occur. The energy consumed for the driving is converted to heat. Thus, waste-heat from the driving members must be taken into account. Ordinarily, in such cases, constant temperature water is circulated to eliminate the heat. To circulate constant temperature water through a stage which is repeatedly moved, a flexible resin-

tube must be used.

[0006]

It has been proposed to use a flexible metallic tube. However, with repeated movement, the metal may become fatigued. Thus, it would become necessary to frequently replace the metallic tubes. On the other hand, resin tubes are sufficiently durable for the repeated movement, and thus, are superior in safety and economy. However, the resin tubes are made of high polymer compounds, so that components of the high polymer compounds may be decomposed and gasified, although the amounts are slight, resulting in the above described problems.

[0007]

At present, the development of a material for the tubes, such as fluorine-containing resins, from which a smaller amount of organic substance is released, compared to known polyurethane tubes or the like has been investigated. However, in contrast to the emission of gas from an inorganic material, the emission of gas from an organic component is not negligible.

[0008]

Patent Document 1 discloses an exposure apparatus with which the amount of a gas component emitted from a resin tube can be reduced, even if the resin tube is arranged in a vacuum environment, as described with respect to the above-

described exposure apparatuses using EUV rays and electron beams. Patent Document 1 discloses an exposure apparatus provided with a double piping composed of an inside piping made of resin and an outside piping also made of resin, that covers the outside periphery of the inside piping, and a gas-exhausting mechanism for exhausting gas present in the space defined by the inside and outside pipings.

[0009]

[Patent Document 1]

Japanese Patent Laid-Open No. 2001-297967

[0010]

[Problems to be Solved by the Invention]

However, the constitution disclosed in Patent Document 1 does not address the cases where it is necessary to further enhance the purity of an inert gas filled in the exposure space and the optical path space, to further enhance the vacuum (to decrease the atmospheric pressure), and to further reduce the concentration of gas which becomes a material deposited on and adhering to the optical elements (causing the contamination).

[0011]

[Means for Solving the Problems]

To solve the above-described problems, the exposure apparatus of the present invention having a resin part inside thereof is provided with a temperature controlling

means for maintaining the surface of the resin part at a predetermined temperature or lower.

[0012]

[Description of the Embodiments]

Embodiments of the present invention will now be described in detail in accordance with the drawings.

[0013]

(First Embodiment)

Fig. 1 shows an EUV exposure apparatus of an embodiment of the present invention. In Fig. 1, reference numeral 1 designates a constant temperature water circulating apparatus, 2 does a temperature controller, 3 does a wafer-temperature sensor, 4 does a temperature sensor for the inner wall of the exposure apparatus, 5 does a feed-piping for supplying constant-temperature water from the constant-temperature water circulating apparatus, 6 does a return-piping similar to the feed-piping, 7 does feed-piping internal to the exposure apparatus, 8 does return-piping internal to the exposure apparatus, 9 does a chamber enclosing at least a part of the exposure apparatus so that the inside of the exposure apparatus can be kept in the vacuum state, 10 does a wafer stage platen, 11 does a wafer, 12 does a wafer stage, 13 does a reticle stage support, 14 does a reticle stage, 15 does a reflection type reticle, 16 does a projection optical system (the system contains a

mirror for guiding a light beam reflected from the reflection type reticle 15 to the water 11 and excludes a mirror for guiding a light beam to the reflection type reticle), 17 does a residual gas analyzer, 18 does a chamber-exhausting system, 19 does an EUV illuminating optical system, 20 does a mirror (reflecting member) having a thin film formed thereof to reflect EUV beams, and 21 does a mirror (reflecting member) which is a part of the above-described projection optical system 16.

[0014]

The reflection type reticle is irradiated with a EUV beam guided from an optical source (not shown) to the exposure apparatus chamber via the illuminating optical system 19 and the mirror 21. The reflected beam is reduced by means of a projection optical system 16 in a body tube (not shown) and is projected onto the wafer. In this case, the beam is formed into a slit-shape by means of the projection optical system, and then, the reticle is irradiated with the beam. The reticle and the wafer are scanned at scanning velocities corresponding to the reduction-magnification ratios thereof. Thus, exposure is carried out. The exposure apparatus has a mechanism in which the reticle (or a mask) is held by means of a reticle chuck (not shown) to be mounted on the reticle stage, the wafer is held by means of a wafer chuck (not shown) to be

mounted on the wafer stage, and the reticle stage and the wafer stage are scanned synchronously at a velocity ratio proportional to the reduction-magnification.

[0015]

Referring to the scanning direction, X represents a scanning direction on the reticle-surface or the wafer-surface, Z represents the direction perpendicular to the reticle-surface or wafer-surface, and Y represents the direction perpendicular to both of the X-axis and the Z-axis.

[0016]

The reticle stage has a mechanism (not shown) by which the stage can be moved at a high speed. It is necessary for the movement distance to be in such a range as exceeds the width of an original pattern formed on the reticle, specifically, in the range of about 100 mm to 300 mm. Moreover, the reticle stage has a fine-movement mechanism (not shown) for movement in the X-, Y-, and Z-directions and in the rotational directions around the respective axes. Thus, the reticle can be positioned. The position and the orientation of the reticle stage are measured with a laser interferometer, and are controlled based on the measurement results.

[0017]

Similarly to the reticle stage, the wafer stage has a mechanism (not shown) by which the stage can be moved in the

X-direction at a high speed. Moreover, the reticle stage has a fine-movement mechanism (not shown) for movement in the X-, Y-, and Z-directions and in the rotational directions on the respective axes. Thus, the wafer can be positioned. The position and the orientation of the wafer stage are measured with a laser interferometer, and are controlled based on the measurement results.

[0018]

The positional relationship between the position of the reticle and the optical axis of the projection optical system, and the positional relationship between the position of the wafer and the optical axis of the projection optical system, are measured by means of an alignment detecting mechanism. The positions and the angles of the reticle stage and the wafer stage are set so that the projection image of the reticle is formed at a predetermined position on the wafer.

[0019]

The focus-position in the Z-direction on the wafer surface is measured by means of a focus-position detecting mechanism. The wafer surface is always kept at the image-forming position of the projection optical system during the exposure by controlling the position and the angle of the wafer stage.

[0020]

After scan-exposure (scan-exposure for one shot area of exposure area) is carried out one time on the wafer, the wafer stage is stepped in the X- and Y-directions to the next scan-exposure start position. The reticle stage and the wafer stage are then synchronously scanned in the X-direction at a velocity ratio proportional to the reduction-magnification of the projection optical system.

[0021]

As described above, the reticle and the wafer are synchronously scanned while the reduction projection image of the reticle is formed on the wafer. This process (i.e., step and scan) is repeated. Thus, the transfer pattern of the reticle is transferred onto the whole surface of the wafer. Thus, it is necessary for the wafer stage to move the whole surface of the wafer to the exposure positions. Accordingly, the exposure apparatus is required to have a configuration such that the wafer stage can be moved in a wide range. Specifically, the exposure apparatus is required to have a configuration such that it can be moved by at least 300 mm in each of the X- and Y-directions.

[0022]

In this embodiment, a resin tube, which is flexible and durable, is used as piping (tube) through which circulation water for cooling the stage movable by at least 300 mm flows, or as piping (and wiring) connecting the movable stage to

the substantially fixed or fixed chamber. To reduce the amount of gas emitted from the resin tube in the vacuum state as much as possible, methods of cooling the resin surface have been devised. According to one of the methods, constant-temperature water set at a lower temperature than the inside of the exposure apparatus is circulated in the resin tube.

[0023]

The temperature of the inner wall of the exposure apparatus was measured as shown in Fig. 1. The temperature of the inner wall was 23°C, which was substantially equal to the temperature of CR. The temperature of the wafer surface is controlled so that the exposure can be carried out at 25°C. Thus, the temperature of water (another liquid may be used) circulated in the resin tube was set at 13°C, which was about 10°C lower than the temperature, i.e., 23°C of the inner wall of the exposure apparatus. This temperature is the lower one of the above-described two temperatures (preferably, the water temperature is set to be lower by at least 10°C than the lower one of the temperature of the inner wall at the surface of the exposure apparatus and the temperature at the surface of the wafer). By setting the temperature as described above, the surface temperature of the resin tube in the feed-path of the constant-temperature water circulating path was kept at approximately 13°C. The

surface temperature of the resin tube in the return-path became about 14°C or higher, but was kept at a sufficiently lower temperature than the temperature of the wall in the exposure apparatus, i.e., 23°C.

[0024]

Fig. 2 shows an example of a mass spectra obtained by measurement of a residual gas component in the vacuum chamber using a four-pole mass spectrometer. Specifically, reference numeral 32 represents the mass spectrum obtained when a urethane resin tube was disposed in the vacuum chamber while water was circulated outside of the urethane resin to cool the tube. Reference numeral 31 represents the mass spectrum obtained when the urethane resin tube was disposed and not cooled. The mass is plotted as the abscissa, and the output current of the mass spectrometer as the ordinate. The output current is substantially proportional to the partial pressure of the residual gas component. To compare both of the residual gas components with respect to their organic components, Fig. 2 shows the measurement results of substances having a mass of 40 or higher. Per Fig. 2, the output currents obtained when constant temperature water at 13°C was circulated in the urethane tube and when the water was not circulated, exhibit a difference of approximately one or two orders of magnitude. This means that the outgassing (emitted gas) from the

urethane tube can be considerably suppressed by reducing the temperature of the urethane tube by about 10°C as compared to the temperature of the exposure chamber.

[0025]

As described above, the outgassing from the resin tube can be suppressed by reducing the temperature of the resin tube. The lower the temperature of the resin tube, the more the outgassing is suppressed. However, when the resin tube temperature becomes excessively low, some obstacles occur. First, to lower the temperature of the resin tube to 0°C or below, it is necessary, for example, to use an anti-freezing fluid in place of water. Moreover, the lower the temperature of the resin tube, the more rigid the resin becomes. Thus, the flexibility of the resin, which is a characteristic inherent in resin, deteriorates. Furthermore, additional problems include occurrence of condensation on the circulation-supplying piping positioned outside the chamber and the feed-through portion in the chamber wall. To eliminate the above-described obstacles, preferably, the temperature of the circulated water is set to be between 5°C and 18°C. Moreover, to prevent a reduction in cooling efficiency, countermeasures such as winding a heat insulating material around the pipings provided outside the chamber can be used.

[0026]

In the case in which air-bearings are used as guides for the stages, it is required to supply gas to the bearings through a flexible resin tube. In this case, the temperature of the gas to be supplied is also set to be low, e.g., 10°C before being supplied. Thereby, the surface temperature of the resin tube can be kept lower than that of the inner wall of the exposure apparatus or that of the wafer at exposure and, hence, the adhesion of deposited substances on the optical elements in the exposure apparatus can be prevented.

[0027]

(Second Embodiment)

Fig. 3 shows a second embodiment of the present invention. Hereinafter, mainly, the wafer stage and its surrounding elements will be described with reference to Fig. 3. The description of the elements identical to those depicted in Fig. 1 will not be repeated. Reference numeral 41 represents a mirror of an interference system is designated, 42 does a wafer positional reference point by, 43 does a wafer chuck for supporting the wafer 11, 44 does a seat on which the wafer chuck and a wafer position-measuring device (not shown) are placed, 45 does a Peltier device, 46 does a temperature sensor for the wafer stage, 47 does a temperature sensor for the seat 44, 48 does a controller which calculates a measured temperature difference to drive

the Peltier device, and 49 does a cable for driving the Peltier device.

[0028]

Similarly to the first embodiment, constant temperature water is circulated because of the waste heat in the wafer-stage driving part of the exposure apparatus. In this case, a resin tube is used, and the constant temperature is set at 10°C. The heat quantity eliminated by the circulation of water with a low constant-temperature is greater than the waste heat in the driving part. Thus, the wafer stage is cooled so that the temperature reaches that of the constant-temperature water. The wafer chuck, a wafer positional reference mark for positioning the stage, a member for measuring the wafer position, such as a mirror as an interferometer useful for position-measurement, or the like are disposed on the wafer stage. Cooling of the wafer stage influences the portion of the wafer stage in which the wafer chuck and the wafer positional reference position are disposed, so that the temperature of that portion becomes lower than a target value. As such, the distance between the wafer and the position-measuring device may be changed. Thus, the correct position can not be measured.

[0029]

In this embodiment, the seat on which the wafer chuck, the wafer positional reference point, the mirror of the

interferometer, and the like are placed is provided. The Peltier device is inserted between the seat and the wafer stage driving part of the exposure apparatus. The difference between the temperatures of the wafer stage driving part and the seat is measured. Voltage is applied to the Peltier device so that the wafer has a target temperature at exposure. The target temperature is set for each seat. The Peltier device can provide a difference between the temperatures of the upper and lower surfaces thereof, which depends on the applied voltage thereto. In this embodiment, the target temperature of the wafer at exposure is set at 25°C. The temperature of the wafer stage driving part is measured. If a change in the temperature is found, the voltage applied to the Peltier device is controlled so as to compensate for the change, so that the seat is kept at a temperature of 25°C.

[0030]

In this embodiment, the Peltier device, which can compensate for the temperature difference, is used. Similarly, a heater may be inserted between the seat and the wafer stage driving part to control the temperature. In this case, the same operation as described above can be achieved.

[0031]

As described above, it is a main object of the present

invention to keep the surface of the resin at a lower temperature than the inside of the exposure apparatus. According to this embodiment, the influence of the above-described temperature-control over the exposure apparatus can be prevented as much as possible.

[0032]

In this embodiment, the wafer stage is described by way of an example. The above-description may be applied to the reticle stage. Moreover, for the optical elements (e.g., a mirror, a shutter, a stop and the like) constituting the optical system, especially for optical elements which can be driven, the circulation of the cooling water and the temperature control can be applied similarly to this embodiment.

[0033]

(Third Embodiment)

Hereinafter, a third embodiment of the present invention will be described with reference to Fig. 4. Fig. 4 shows only a driving system that is a part of the wafer stage of the exposure apparatus in the vacuum state. In Fig. 4, reference numeral 51 designates an electronic substrate made of resin having a driver circuit formed therein to drive the stage, 52 does a resin connector connected to a feed-through of the chamber, 53 does a power source supply cable made of resin, 54 does cables for feeding a signal to

the respective parts of the stage, 55 does resin connectors for the cables on the circuit side, 56 does a feed-through for feeding power or a signal from the outside of the chamber, 57 does a cable for power and a signal to be supplied from an exposure apparatus controller (not shown), 58 does cooling water piping, and 59 does cooling-water metallic piping arranged in contact with the connector 52 and the substrate for cooling.

[0034]

In the above-described embodiments, the surface of a resin tube, which is flexible, is kept at a low temperature by way of an example. On the other hand, in this embodiment, parts made of resin and set in the fixed state are cooled. The stage is driven with a linear motor. Thus, the power consumption is large. Accordingly, a large amount of power is applied to the driver circuit and the cables and provided before and after the driver circuit and connected thereto. Thus, a large current flows through the cables and the connectors, which are significantly heated. Moreover, the driver circuit is heated as well. The driver circuit or the like is provided outside the chamber, if possible. However, in some cases, such circuits must be positioned near the driving part. In such cases, the temperature of the connectors, the cables, and the substrate, which are made of resin, becomes higher than the ambient temperature. As a

result, a relatively large amount of gas is emitted from the resin surfaces. This in turn may cause the optical elements to deteriorate as described above. According to the third embodiment, the metallic piping is placed in contact with the resin parts. In addition, metallic blocks having high heat conductivity are placed in contact with the resin parts, so that the resin surfaces are cooled as much as possible. Even for structures which can be completely covered and cooled with much difficulty, such as the connectors, the cables, and the like, their resin surfaces, although the heat conduction is inferior, can be lowered to about 15°C, e.g., by circulation of cooling water having a temperature of about 5°C. As described above, the ratio of organic material of the residual gas components in the exposure apparatus can be reduced by lowering the resin surface temperature, even if the degree of reduction is small. Thus, the deterioration of the optical elements in the exposure apparatus can be suppressed, and the performance of the exposure apparatus can be maintained.

[0035]

Materials which may be deposited on and adhere to the surfaces of the optical elements can be reduced by cooling the resin parts which are arranged near heat sources, such as the electronic substrate, the power supply cable, other relevant electric parts, and parts capable of absorbing

light to generate heat, by use of the cooling mechanism of the above-described embodiment.

[0036]

Moreover, according to the above-described embodiment, the resin parts (e.g., resin tubes, urethane tubes or the like) are cooled mainly by using cooling water. However, the invention is not limited to cooling water. The resin parts may be cooled with cooled air (any kind of gas may be applied, and preferably, an inert gas is used). Moreover, radiation may be used to cool the surfaces of the resin parts (temperature-control). Furthermore, a combination of cooling by radiation with the temperature-control using a Peltier device (cooling and heating) may be used.

[0037]

Also, according to this embodiment, the surface temperature of the resin tube is controlled based on the temperatures of the inner walls in the exposure apparatus, the wafer surface, and the like. This control is not restrictive. The temperature of any member of the exposure apparatus (e.g., an optical element such as a mirror, a supporting member for supporting the mirror or the like, the barrel, the reticle stage, the wafer stage, etc.) may be used as a reference for controlling the surface temperature of the resin tube.

[0038]

In the first to third embodiments, the temperature of the liquid or gas flowing through the resin tube is appropriately adjusted. The exposure apparatus may have such a constitution that two kinds of fluids (liquids or gases) can be flown through the resin tube (two pipes are arranged in one piping in the exposure apparatus, so that two kinds of fluids can be flown). Preferably, the resin tube has a double structure, i.e., an inner resin tube and an outer resin tube. A fluid having a temperature suitable for cooling objects to be cooled (the stages, the mirrors, and the like) would flow through the inside resin tube. A fluid having a temperature which is suitably adjusted to prevent a material (e.g., a carbon compound or the like) that tends to be deposited on and adhere to the surfaces of the optical elements from being scattered from the outside resin tube in the exposure apparatus flows through the space between the outside and inside resin tubes (the temperature of the fluid flowing through the space is set to be lower than that of the fluid flowing through the inside resin tube).

[0039]

(Fourth Embodiment)

Hereinafter, an embodiment of a method of producing a device using the above-described exposure apparatus will be described. Fig. 5 is a flow chart showing the production of

a device (semiconductor chips such as IC or LSI, LCDs, CCDs, etc.). The production of a semiconductor chip will be described below by way of an example. At step S1 (circuit design), the circuit of the device is designed. At step S2 (mask formation), a mask having the pattern of the designed circuit is produced. At step S3 (wafer formation), a wafer is produced using a material such as silicon or the like. Step S4 (wafer processing) is called "pre-processing", in that a circuit to be practically used is formed on the wafer according to a lithographic technique using the mask and the wafer. Step S5 (construction) is called "post-processing", in that a semiconductor chip is formed using the wafer produced in step S4. Step S5 includes an assembly process (dicing and bonding), a packaging process (chip sealing), and so forth. At step S6 (inspection), the operation, durability and the like of the semiconductor device formed in step S5 are tested. The semiconductor device is produced via the above steps, and is shipped (step S7).

[0040]

Fig. 6 is a flow chart showing the wafer process of step S4 in detail. At step S11 (oxidation), the surface of the wafer is oxidized. At step S12 (CVD), an insulation film is formed on the surface of the wafer. At step S13 (formation of electrode), an electrode is formed on the wafer by vapor deposition or the like. At step S14 (ion

implantation), ions are implanted into the wafer. At step S15 (resist processing), a photosensitive material is coated on the wafer. At step S16 (exposure), the wafer is exposed via the mask having the circuit pattern formed thereon by means of one of the exposure apparatuses 100 to 400. At step S17 (development), the exposed wafer is developed. At step S18 (etching), the surface of the wafer, excluding the developed resist image, is removed. At step S19, (resist removal), the resist, which becomes unnecessary after the etching, is removed. These steps are repeated, and thereby, multiple circuit patterns are formed on the wafer. According to the method of producing a device of this embodiment, a higher grade device can be produced compared to any one of such known devices. The present invention provides a method of producing a device using one of the exposure apparatuses 100 to 400 described above and a device produced by the method of the present invention.

[0041]

Preferred embodiments of the present invention are described above. The present invention is not limited to the above-described embodiments. Different modifications and changes of the present invention can be made without departing from the spirit and scope thereof.

[0042]

Embodiments of the present invention may be expressed

as follows:

(Embodiment 1) An exposure apparatus comprising a part made of resin inside thereof, and a temperature control means for keeping the surface temperature of the resin part at a predetermined temperature or lower.

(Embodiment 2) An exposure apparatus according to Embodiment 1, wherein the predetermined temperature is lower than the temperature of a piece to be treated (wafer) and/or the temperature of the inner wall of the exposure apparatus.

(Embodiment 3) An exposure apparatus according to Embodiment 1 or 2, wherein the predetermined temperature is 18°C or lower.

(Embodiment 4) An exposure apparatus according to any one of Embodiments 1 to 3, wherein the predetermined temperature is at least 5°C lower than the temperature of the piece to be treated.

(Embodiment 5) An exposure apparatus according to any one of Embodiments 1 to 4, wherein the apparatus has a function of cooling a resin part disposed near a heat source inside of the exposure apparatus.

[Embodiment 6) An exposure apparatus according to any one of Embodiments 1 to 5, wherein the apparatus contains a resin piping inside thereof, and includes a temperature control mechanism for controlling a fluid (liquid or gas) flowing in the piping at the predetermined temperature or

lower.

(Embodiment 7) An exposure apparatus according to any one of Embodiments 1 to 6, wherein the apparatus includes

a resin piping inside thereof,

a mechanism for cooling a fluid (liquid or gas) flowing through the piping to have a temperature lower than the piece to be treated and supplying the fluid in the apparatus, and

a mechanism for heating at least a portion of a unit in the exposure apparatus to which the liquid or gas is supplied (or a device for controlling a temperature difference between the front and back sides).

(Embodiment 8) An exposure apparatus according to Embodiment 7, wherein the mechanism for overheating at least a portion of the unit contains a Peltier device.

(Embodiment 9) An exposure apparatus according to any one of Embodiments 1 to 8, wherein the inside of the exposure apparatus is maintained in the vacuum state.

(Embodiment 10) An exposure apparatus according to any one of Embodiments 1 to 9, wherein the predetermined temperature is set to be lower than the temperature of a predetermined part in the exposure apparatus.

(Embodiment 11) An exposure apparatus according to any one of Embodiments 1 to 10, wherein the predetermined temperature is at least 10°C lower than the temperature of

the inner wall of a chamber (surrounding member) which maintains the inside of the exposure apparatus in the vacuum state.

(Embodiment 12) An exposure apparatus according to any one of Embodiments 1 to 11, wherein the piping has a first pipe for flowing a first fluid and a second pipe for flowing a second fluid.

(Embodiment 13) An exposure apparatus according to Embodiments 12, wherein the temperature of the first fluid and that of the second fluid are different from each other.

(Embodiment 14) An exposure apparatus according to Embodiment 12 or 13, wherein in the cross-section of the piping, the first pipe is arranged so as to surround the second pipe on the outer side.

(Embodiment 15) An exposure apparatus according to Embodiment 14, wherein in the cross-section of the piping, the second pipe surrounds the first pipe on the outer side.

(Embodiment 16) An exposure apparatus according to Embodiment 14 or 15, wherein the temperature of the second fluid is lower than that of the first fluid.

(Embodiment 17) An exposure apparatus according to any one of Embodiments 14 to 16, wherein the temperature of the second fluid is lower than the predetermined temperature.

(Embodiment 18) An exposure apparatus according to any one of Embodiments 14 to 17, wherein the temperature of the

second fluid is lower than that of the predetermined part in the exposure apparatus.

(Embodiment 19) An exposure apparatus according to any one of Embodiments 14 to 18, wherein the temperature of the second fluid is lower than that of the piece to be treated.

(Embodiment 20) An exposure apparatus according to any one of Embodiments 14 to 19, wherein the temperature of the second fluid is at least 10℃ lower than that of the inner wall of the chamber (surrounding member) which maintains the inside of the exposure apparatus in the vacuum state.

(Embodiment 21) A method of producing a device comprising the steps of exposing a piece to be treated by use of the exposure apparatus according to any one of Embodiments 1 to 20, and developing the exposed treatment-piece.

[0043]

According to Embodiment 1, the amount of organic components released from the surface of the resin part can be estimated. According to Embodiment 2, the release of organic components from the surface of the resin part can be more limited, so that the concentration of the organic components in the exposure space can be reduced. According to Embodiment 3, the conditions required to limit the release of the organic components from the surface of the resin part can be definitely expressed as an absolute value, and thus, the concentration of the organic components in the

exposure space can be kept low. According to Embodiment 4, the conditions required to limit the release of the organic components from the surface of the resin part can be relatively defined, and thus, the concentration of the organic components in the exposure space can be kept low. According to Embodiment 5, the release of the organic components from the surface of the resin part can be reduced. Moreover, According to Embodiment 6, the release of the organic components from the surface of the resin part can be limited, and thus, the concentration of the organic components in the exposure space can be reduced. According to Embodiment 7, the concentration of the organic components in the exposure space can be reduced while the temperature of a wafer is kept constant.

[0044]

According to the present invention, the release of organic components from the surface of a resin part can be more limited. Thus, the concentration of the organic components in the exposure space can be reduced.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 illustrates the configuration of a EUV exposure apparatus according to a first embodiment.

[Fig. 2]

Fig. 2 illustrates the effect of the first embodiment

on the prevention of gas-emission.

[Fig. 3]

Fig. 3 illustrates a second embodiment.

[Fig. 4]

Fig. 4 illustrates a third embodiment.

[Fig. 5]

Fig. 5 is a flow chart showing a method of producing a device containing the exposure apparatus of the present invention.

[Fig. 6]

Fig. 6 is a flow chart showing a wafer-processing as step 4 shown in Fig. 5.

[Reference Numerals]

1: constant temperature water circulating apparatus

2: temperature controller

3: wafer-temperature sensor

4: temperature sensor for inner wall of exposure apparatus

5: feed-piping for supplying constant-temperature water from constant-temperature water circulating apparatus

6: return-piping for supplying constant-temperature water from constant-temperature water circulating apparatus

7: feed-piping internal to the exposure apparatus

8: return-piping internal to the exposure apparatus

11: wafer

12: wafer

[Name of Document] ABSTRACT

[Abstract]

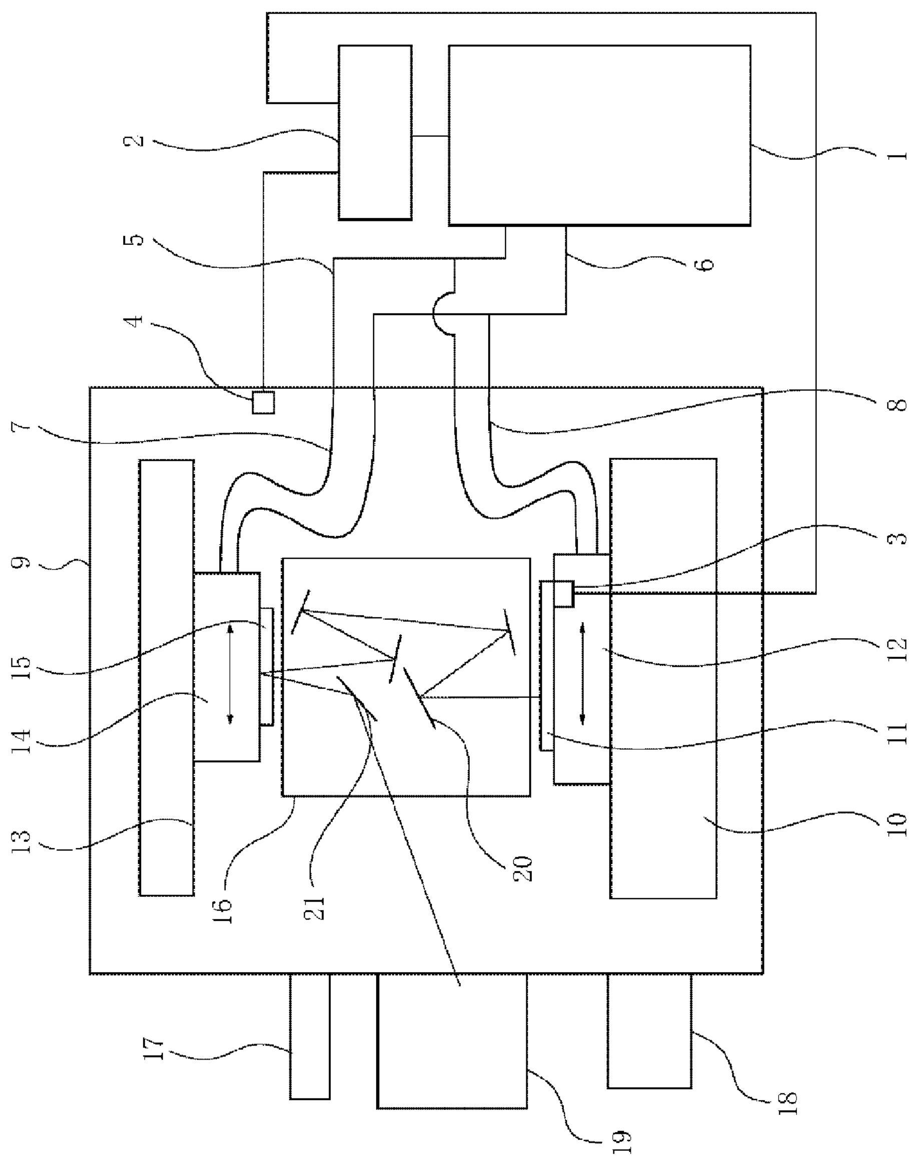
[Problems] When the inside of an exposure apparatus is placed under vacuum, gas is emitted from a resin tube provided in the exposure apparatus, and a component of the gas adheres to and is deposited on the surface of an optical element, so that the optical performances of the optical element and the exposure apparatus are deteriorated.

[Solving Means] The exposure apparatus includes a resin tube inside thereof, and temperature control means for controlling the surface temperature of the resin tube at a predetermined temperature or lower.

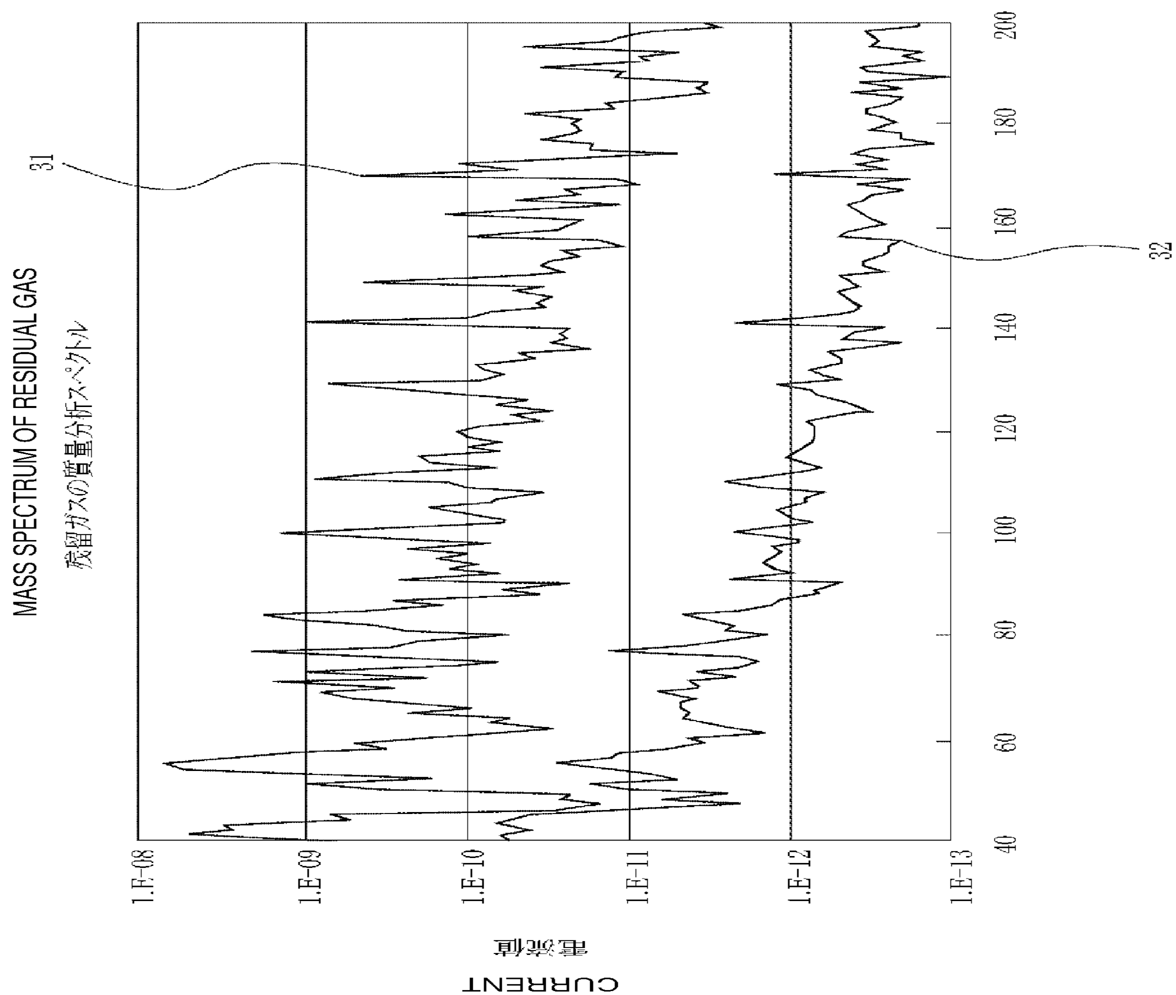
[Selected Figure] Fig. 1

【書類名】　図面　[Name of Document] DRAWINGS

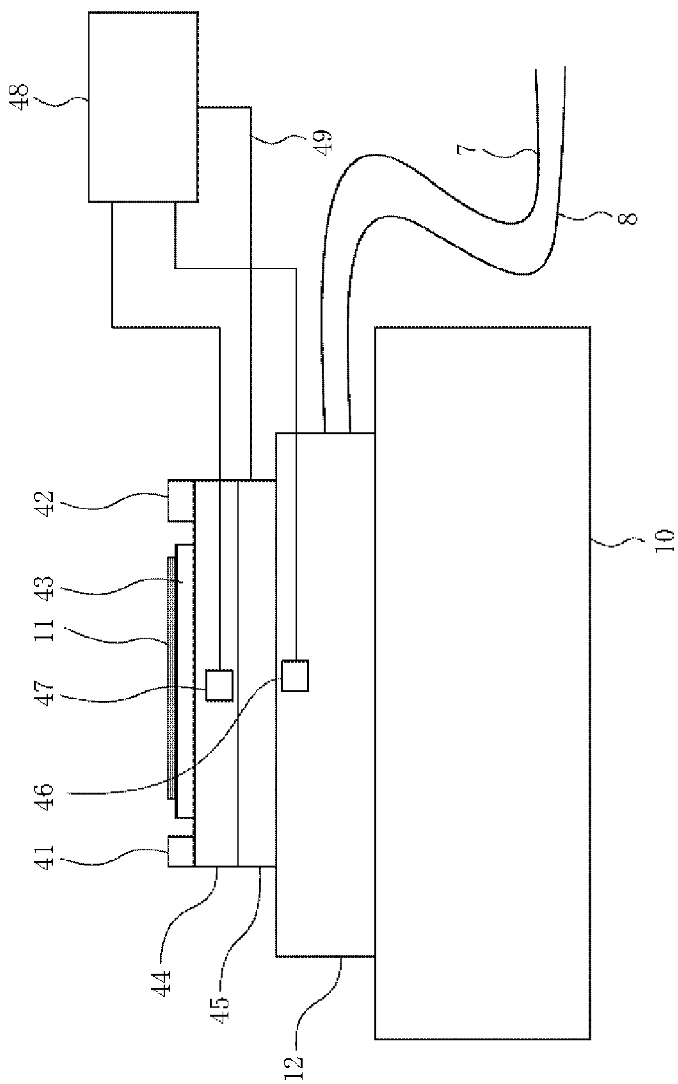
【図１】　[Fig. 1]



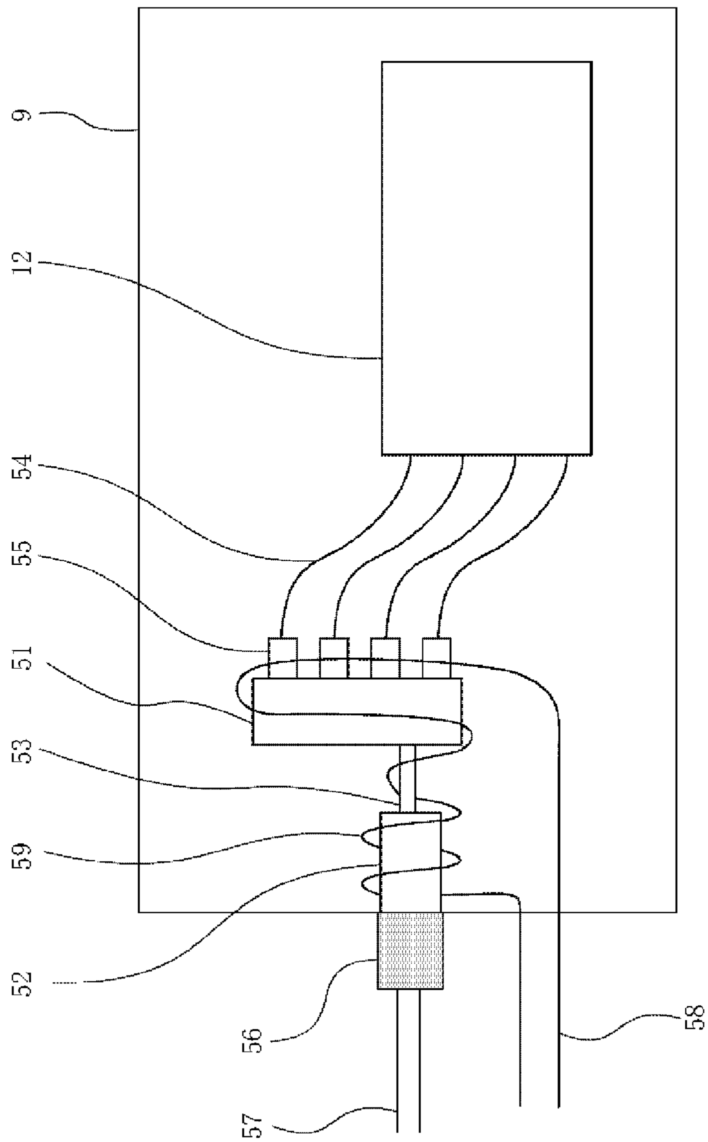
【図２】　[Fig. 2]


MASS SPECTRUM OF RESIDUAL GAS
残留ガスの質量分析スペクトル
CURRENT
電流値
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-13
40
60
80
100
120
140
160
180
200
31
32

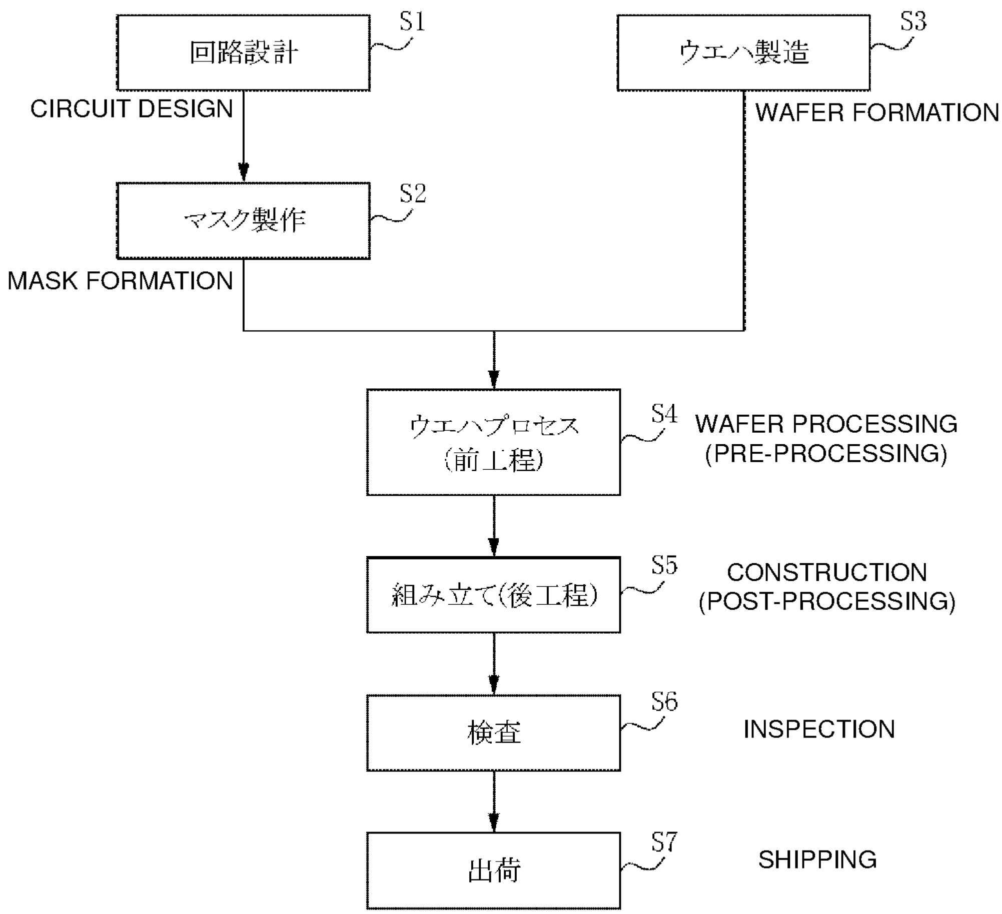
【図３】　[Fig. 3]



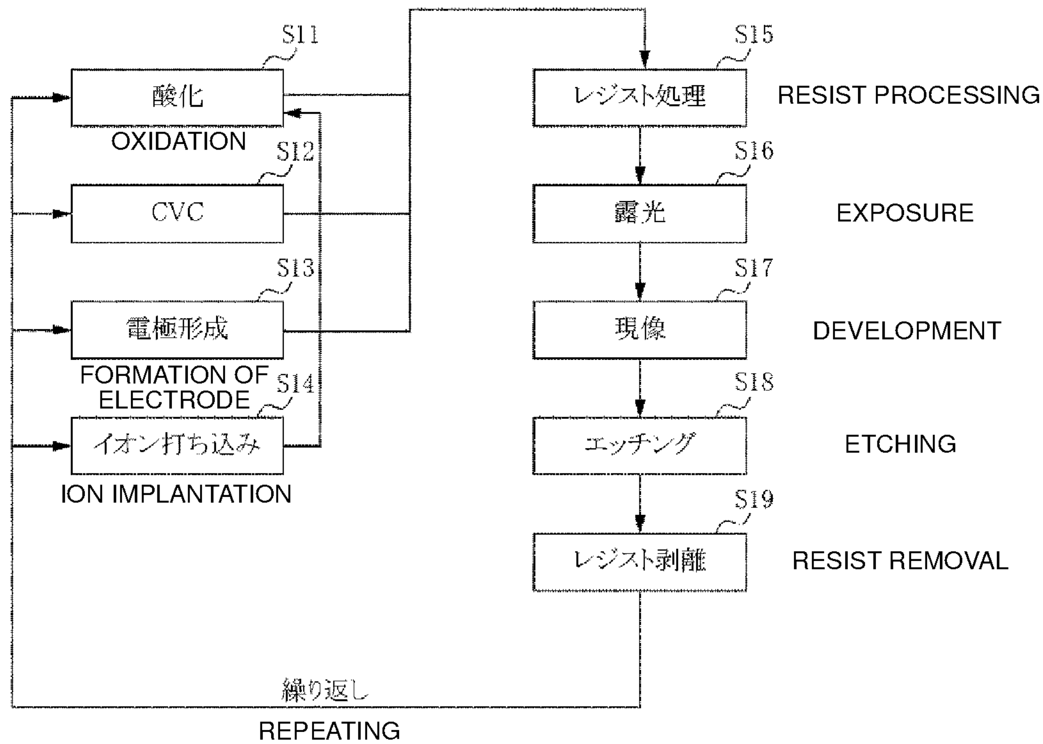
【図４】 [Fig. 4]



【図５】　[Fig. 5]


回路設計
S1
CIRCUIT DESIGN
ウエハ製造
S3
WAFER FORMATION
マスク製作
S2
MASK FORMATION
ウエハプロセス
(前工程)
S4
WAFER PROCESSING
(PRE-PROCESSING)
組み立て(後工程)
S5
CONSTRUCTION
(POST-PROCESSING)
検査
S6
INSPECTION
出荷
S7
SHIPPING

【図６】 [Fig. 6]


S11
酸化
OXIDATION
S12
CVC
S13
電極形成
FORMATION OF ELECTRODE
S14
イオン打ち込み
ION IMPLANTATION
S15
レジスト処理
RESIST PROCESSING
S16
露光
EXPOSURE
S17
現像
DEVELOPMENT
S18
エッチング
ETCHING
S19
レジスト剥離
RESIST REMOVAL
繰り返し
REPEATING